

among female nuclear workers; a multi-site exposure assessment of hazardous waste/cleanup workers; a chronic beryllium disease study; and a multi-site study of heat stress and performance among carpenters.

M.4.7 SAVANNAH RIVER SITE

The Savannah River Site, established in 1953 in Aiken, SC, produced Pu, tritium, and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in surface and groundwater streams (ED 1982a:135-152).

Surrounding Communities. In 1984, Sauer and Associates examined mortality rates in Georgia and South Carolina by distance from the Savannah River Plant (now known as the SRS) (SR duPont 1984b). Rates for areas near the plant were compared with U.S. rates and with rates for counties located more than 50 miles away. Breast cancer, respiratory cancer, leukemia, thyroid cancer, bone cancer, malignant melanoma of the skin, non-respiratory cancer, congenital anomalies or birth defects, early infancy death rates, stroke, or cardiovascular disease in the populations living near the plant did not show any excess risk compared with the reference populations.

State Health Agreement Program. Under the State Health Agreement program managed by the DOE Office of Epidemiologic Studies, a grant was awarded to the Medical University of South Carolina in 1991 to develop the Savannah River Region Health Information System. The purpose of the Savannah River Region Health Information System database was to assess the health of populations surrounding SRS by tracking cancer rates and, birth defect rates in the area. Information from the registry is available to public and private health care providers for use in evaluating cancer control efforts. A steering committee provides advice to the Savannah River Region Health Information System and communicates public concerns to Savannah River Region Health Information System. It consists of 12-community members and persons with technical expertise representing South Carolina and Georgia. The meetings are open to the public.

Workers. A descriptive mortality study was conducted that included 9,860 white male workers who had been employed at least 90 days at the Savannah River Plant between 1952 and the end of 1974 (AJIM 1988b:370-401). Vital status was followed through the end of 1980 and mortality was compared with the U.S. population. SMRs were computed separately for hourly and salaried employees. For hourly employees non-statistically significant increases were seen for cancer of the rectum (SMR=1.09, 5 observed, 95 percent CI=0.35-2.54), cancer of the pancreas (SMR=1.08, 10 observed, 95 percent CI=0.59-2.18), leukemia and aleukemia (SMR=1.63, 13 observed, 95 percent CI=0.87-2.80), other lymphatic tissue (SMR=1.06, 5 observed, 95 percent CI=0.34-2.48), benign neoplasms (SMR=1.33, 4 observed, 95 percent CI=0.36-3.40), and motor vehicle accidents (SMR=1.10, 63 observed, 95 percent CI=0.84-1.4). Salaried employees exhibited non-statistically significant increases in cancer of the liver (SMR=1.84, 3 observed, 95 percent CI=0.38-5.38), cancer of the prostate (SMR=1.35, 5 observed, 95 percent CI=0.44-3.16), cancer of the bladder-(SMR=1.87, 4 observed, 95 percent CI=0.51 4.79), brain cancer (SMR=1.06, 4,observed, 95 percent CI=0.29-2.72), leukemia and aleukemia (SMR=1.05, 4 observed, 95 percent CI=0.29-2.69), and other lymphatic tissue (SMR=1.23, 3 observed, 95 percent CI=0.26-3.61). No trends between increasing duration of employment and SMRs were observed. A statistically significant excess of leukemia deaths was observed for hourly workers employed at least 5, but less than 15 years (SMR=2.75, 6 observed, 95 percent CI=1.01-5.99). Review of the plant records and job duties of the workers who died from leukemia indicated that two of the cases had potential routine exposure to solvents, four had potential occasional exposure to solvents and one had potential for minimal exposure. Benzene, a known carcinogen was reportedly not used at the plant.

Epidemiologic Studies. The Department's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at SRS to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis and the results will be issued in annual reports. The implementation of this program will facilitate an ongoing assessment of the health and safety of SRS's workforce and will help identify emerging health issues.

Currently operational at a number of DOE sites, including production sites and R&D facilities, epidemiologic surveillance uses routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data for an extended period of time become available, time trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring the health of the workforce provides a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate the need for more detailed study or increased health and safety measures to ensure adequate protection for workers.

Memorandum of Understanding. The Department entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The Centers for Disease Control and Prevention's National Center for Environmental Health is responsible for dose reconstruction studies and NIOSH is responsible for worker studies. These activities are funded by DOE.

A study of mortality among SRS workers employed from 1952 to 1974 to examine whether risks of death due to selected causes may be related to occupational exposures at SRS is being conducted by NIOSH. SRS is also included in several multisite studies managed by NIOSH. The first study is to assess the potential association between paternal work-related exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers. The second study is to examine causes of death among female workers at nuclear weapons facilities to develop risk estimates based on exposures to external and internal ionizing radiation and to hazardous chemicals. A third multi-site project is a case-control study of multiple myeloma; a type of blood cell cancer.

A dose reconstruction project around SRS is being conducted by the National Center for Environmental Health to determine the type and amount of contaminants to which people living around the site may have been exposed, to identify exposure pathways of concern and to quantify the doses people may have received as a result of SRS operations. The estimated completion date is 1999 or 2000.

M.4.8 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Surrounding Communities

Johnson examined cancer incidence from 1969 to 1971 among non-Hispanic whites in the Denver area to determine if exposure to a small concentration of Pu and other radionuclides had increased the incidence of cancer (Ambio 1981a:176-182). The authors categorized census tracts into four areas based on Pu isotope concentrations in soil from a 1970 Atomic Energy Commission survey. The highest concentrations of Pu were closest to the Rocky Flats Plant (Area I) and decreased with distance from the plant (Areas II & III). Area IV was considered unexposed. The study calculated cancer incidence rates for each of the four areas. To account for confounding factors, median income and education levels of the study and control populations derived from 1970 census data also were considered.

Cancer incidence appeared to be inversely proportional to the distance from Rocky Flats. Among males, total cancer incidence for 1969-1971 was significantly elevated by 24 percent in Area I and by 15 percent in Area II compared with Area IV. Among women, total cancer incidence was 10 percent higher in Area I than Area IV. When specific cancer sites for each area were compared with Area IV, cancer of the lung and bronchus was significantly elevated in men by 33 percent in Area I and by 46 percent in Area II. Cancers of the colon and rectum were significantly elevated in men by 47 percent and in women by 37 percent in Area I. Leukemia was significantly elevated in women in Area III by 58 percent. There were 18 percent fewer leukemia cases than expected among women in Area I. Cancer of the tongue, pharynx, and esophagus was significantly elevated in

men by 139 percent and in women by 257 percent in Area II. Men in Area II also had significant elevations in liver, gallbladder, and testicular cancers. The author concluded that over the study period, cancer incidence increased with increasing Pu soil concentrations and that exposure of the public to low concentrations of Pu and other radionuclides may effect the incidence of total and radiation-related cancer.

To further investigate these reported geographic correlations between Rocky Flats and cancer incidence patterns, Crump et al. re-examined cancer incidence data for the 3-year period studied by Johnson, 1969 to 1971, and also analyzed data from a later period, 1979-1981 (AJE 1987b:127-135). Crump et al. used the same concentration contours for soil Pu contamination as the Johnson study and computed gender- and age-specific cancer rates for each of the four exposure areas. As in the previous study, Area I, with the highest exposure, was closest to Rocky Flats; Area IV was most distant.

The authors' findings paralleled the earlier results of Johnson for 1969-1971. For 1979-1981, significant positive trends were observed in males for total cancer, "radiosensitive cancer," as defined by BEIR III, and respiratory cancer; and in females for total cancer, radiosensitive cancer, and digestive cancer. Whereas cancer incidence tended to decrease with increasing distance from the Rocky Flats Plant for the 1969-1971 study period, cancer incidence in the 1979-1981 time period was lower in Area I, closer to Rocky Flats, than for Area II in six of the cancer sites studied.

To examine the possible effects of urbanization on cancer incidence, census tracts were then grouped by distance from the State Capitol Building. Total cancer incidence was higher nearer to downtown Denver and the State Capitol for males in the earlier period, and for both sexes in the later period. Cancer incidence rates were found to decrease in all directions as one moved away from the State Capitol, including the direction of Rocky Flats. After controlling for distance from the Capitol, the statistically significant association of increases in various cancers among those living near Rocky Flats disappeared.

The authors then compared that part of Area I closest to Rocky Flats (within 16 km) to the whole Denver metropolitan area. No excess was seen for either males or females during either study period for total cancer, radiosensitive cancer, or respiratory cancer.

Crump et al. concluded that this study did not support a correlation between environmental exposure to Pu from Rocky Flats and cancer incidence; correlations of cancer incidence with proximity to Rocky Flats disappeared for both time periods when analyses took into account the levels of urbanization.

Jablon et al. analyzed cause, gender, race, and age-specific cancer mortality from 1950 through 1984 in residents who lived near 62 nuclear facilities throughout the United States (JAMA 1991a:1403-1408). Each of 107 counties with or near nuclear installations, including Jefferson County, where Rocky Flats is located, was matched to three control counties in the same region, without nuclear facilities. The matching criteria included population size, age, race, urban/rural differences, manufacturing, education, income, migration, and infant death rates. The authors concluded that the survey did not detect any general association between residence in a county with a nuclear facility and death attributable to leukemia or any other form of cancer. The authors noted that interpretation of the study results is limited by its ecologic approach in which the exposures of individuals are not known.

State Health Agreement Program

Under the State Health Agreement program managed by the DOE Office of Epidemiologic Studies, a grant was awarded to the Colorado Department of Public Health and Environment for the performance of an offsite historical dose reconstruction. Due to be completed by 1998, this study includes a thorough examination of major fires and other events releasing Pu from Rocky Flats, estimates of resulting risks due to exposure to Pu and other environmental releases, as well as extensive support of cancer and birth defects registries and public involvement activities.

Workers

Voelz et al. conducted a historical cohort mortality study of 7,112 white male workers ever employed at Rocky Flats between 1952 and 1979 (HP 1983b:493-503).

Cause specific death rates in workers were compared with those in the U.S. white male population adjusted for age and calendar year. Statistically significant fewer deaths were observed than expected based on rates in the U.S. population from all causes (SMR=0.54, 95 percent CI=0.49-0.60), all cancers (SMR=0.64, 95 percent CI=0.52-0.77), digestive organs/peritoneal cancer (SMR=0.66, 95 percent CI=0.44-0.95), and respiratory cancer (SMR=0.58, 95 percent CI=0.40-0.80). Benign and unspecified neoplasms were the only cause of death significantly elevated in these workers with eight cases observed, (SMR=3.32, 95 percent CI=1.43-6.53). All eight tumors were intracranial. The cohort was then stratified by exposure to Pu. Among Pu exposed workers, significantly fewer deaths than expected were observed from all causes of death (SMR=0.38, 95 percent CI=0.31-0.46), all malignant neoplasms (SMR=0.41, 95 percent CI=0.23-0.59), and respiratory cancer (SMR=0.20, 95 percent CI=0.05-0.52). No cases of bone cancer were observed. Workers not exposed to Pu also showed significantly fewer deaths from all causes and all cancers.

Workers exposed to external radiation had significantly fewer deaths from all causes (SMR=0.49, 95 percent CI=0.43-0.54), all cancers (SMR=0.58, 95 percent CI=0.46-0.73), and respiratory cancer (SMR=0.57, 95 percent CI=0.37-0.83) than expected when compared with U.S. white males. Six of the total eight cases of benign and unspecified neoplasms occurred in workers exposed to external radiation. Two occurred in those exposed to Pu.

To investigate whether brain tumor mortality was associated with exposure to internally deposited Pu or external radiation, Reyes et al. conducted a case-control study of all primary brain tumor deaths that occurred among white males who had been employed at Rocky Flats between 1952 and 1977, and died between 1952 and 1980 (JOM 1984b:721-725). Sixteen cases were identified. Four controls were matched to each case on year of birth and period of employment. Demographic data and detailed work histories were obtained from employment records. Exposure data for internally deposited Pu and external radiation data were obtained from Rocky Flats Plant health physics records.

No statistically significant association was found between brain tumor mortality and exposure to Pu or cumulative external radiation exposure. No significant dose response trends were observed for any job or work area. The authors noted that the study was limited by the small number of cases in the study and the small proportion (10 percent) of the cohort who had died.

Tietjen presented mortality data on all causes of death, all cancer deaths, and lung cancer deaths for Rocky Flats workers with exposures greater than 74 Bq (2.0 nanocuries [nCi]) (HP 1987a:625-628). No excess mortality was observed, with fewer deaths from all causes (SMR=0.70, 95 percent CI=0.54-0.89) and lung cancer (SMR=0.14, 95 percent CI=0.0-0.76) than expected compared with U.S. rates. When compared to an internal comparison group, the Risk Ratio (RR) for mortality from all causes was 1.16 (95 percent CI=0.89-1.52) and for lung cancer it was 0.21 (95 percent CI=0.03-1.26).

To further elucidate the risks from exposure to low levels of Pu and external radiation, Wilkinson et al. studied the cohort of workers employed at Rocky Flats between 1952 and 1979 (AJE 1987d:231-250). The analyses were limited to 5,413 white males who were employed for at least 2 years at Rocky Flats. Workers with cumulative exposures >1 rem were considered exposed to external radiation; those with body burdens ≥ 2 nCi were considered exposed to Pu.

Compared with death rates among white males in the United States, significantly fewer deaths were observed than expected from all causes (SMR=0.62, 90 percent CI=0.57-0.68), all cancers (SMR=0.71, 90 percent CI=0.59-0.84), diseases of the circulatory system (SMR=0.61, 90 percent CI=0.54-0.69), accidents, poisonings,

and violence (SMR=0.65, 90 percent CI=0.51-0.81). As reported earlier by Voelz et al., benign and unspecified neoplasms were the only cause of death significantly elevated (SMR=3.16, 90 percent CI=1.77-7.07). Workers with Pu body burdens of ≥ 2 nCi were then compared with workers with less exposure. As cancers take varying times to develop, analyses were conducted considering induction periods of 2, 5, and 10 years. No significant excesses were seen for a 2-year induction period. After a 5-year induction period, significant increases from all causes (RR=1.33, 90 percent CI=1.05-1.68) and lymphopoietic cancer (RR=9.86, 90 percent CI=1.26-94.03) were observed. After 10 years, the excess in death from leukemia was no longer statistically significant (RR=5.22, 90 percent CI=0.57-38.8).

Similar analyses were conducted for workers who received 1 rem or more of external radiation compared with workers less exposed. Workers with ≥ 1 rem had statistically significant fewer deaths from all cancers, when compared with those with < 1 rem. No dose-response relationships for Pu or external radiation were found. The authors noted nonstatistically significant increases in myeloid leukemia, lymphosarcoma and reticulum cell sarcoma, liver neoplasms, and unspecified brain tumors in workers with ≥ 1 rem of external radiation compared with workers with < 1 rem.

Gilbert et al. conducted a combined cohort mortality analysis of white male workers employed at Hanford, Oak Ridge, or Rocky Flats for at least 6 months and monitored for exposure to external radiation (RR 1989a:19-35). Analyses for Rocky Flats were based on the same vital status and cause of death information reported by Wilkinson et al. To eliminate overlap, those who worked at multiple facilities were included in the analysis for the facility where they first met eligibility requirements; doses accumulated at other facilities were excluded. To allow for minimum latency (the time between exposure and the diagnosis of cancer), cumulative dose was lagged 2 years for leukemia and 10 years for other cancers. Expected death rates were derived from age and calendar specific death rates for U.S. white males.

In Rocky Flats workers monitored for external radiation, significantly fewer deaths were observed than expected from all causes, lung cancer, circulatory diseases, respiratory diseases excluding pneumonia, cirrhosis, and external causes. Consistent with previous studies of this cohort, benign and unspecified neoplasms of the brain were the only cause of death significantly elevated (SMR=3.84, 95 percent CI=1.5, 7.9). Unmonitored workers had a borderline statistically significant excess mortality from all cancers (SMR=1.6, 90 percent CI=1.0-2.5) but did not differ from monitored workers with respect to site-specific cancer mortality.

Analyses of mortality by cumulative radiation dose found no indication of increased cancer deaths with increased radiation dose, but a significant positive association was observed between noncancer mortality and radiation exposure. The authors indicated that mortality from circulatory diseases and external causes were contributors to this correlation with noncancer mortality. The authors concluded that there was no evidence of a correlation between chronic low-dose radiation exposure and mortality from all cancer or from leukemia.

In 1993, Gilbert et al. published an update of their previous analyses of data from Hanford, Oak Ridge, and Rocky Flats (RR 1993a:408-421). Four additional years of mortality data for the Rocky Flats cohort were included in this later analysis. As in the previous analysis, the study was limited to white males employed for at least 6 months and monitored for external radiation. All analyses were based on internal comparisons of death rates by level of radiation dose, as internal comparisons were considered by the authors to be less subject to bias and more likely to detect risks resulting from radiation exposure than were comparisons to external populations. Workers were included in the analyses beginning with the year after initial employment plus 5 years, or the first year of monitoring, whichever occurred later.

The previously observed correlation between noncancer mortality and external radiation exposure in Rocky Flats workers was no longer statistically significant, and external causes of death were now negatively correlated with radiation dose. Benign and unspecified neoplasms of the brain, which had been shown to be elevated in previous papers by Voelz and Wilkinson, remained elevated and showed no evidence of any dose

response relationship with external radiation. Deaths from leukemia indicated a positive correlation with external radiation exposure at Rocky Flats, but not at two other facilities considered in the analyses.

An international effort to pool data from populations exposed to external radiation included Rocky Flats workers, as well as workers at Hanford and Oak Ridge in the United States and other radiation worker populations in Canada and Britain (RR 1995a:117-132). The cohort was comprised of 95,673 workers employed 6 months or longer and the population dose was 3,543.2 Sv. There was no evidence of an association between radiation dose and mortality from all causes or from all cancers. There was a significant dose-response relationship with leukemia, excluding chronic lymphocytic leukemia (ERR=2.18 per Sv; 90 percent CI 0.1-5.7) and multiple myeloma (excess relative risk not computed; 44 observed). The authors concluded that the study results did not suggest that current radiation risk estimates for cancer at low levels of exposure are appreciable in error.

Epidemiologic Studies

The Department's Office of Epidemiologic Studies has implemented an epidemiologic surveillance program at Rocky Flats to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis and the results will be issued in annual reports. The implementation of this program will facilitate an ongoing assessment of the health and safety of Rocky Flats' workforce and will help identify emerging health issues.

Currently operational at a number of DOE sites, including production sites and R&D facilities, epidemiologic surveillance uses routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data for an extended period of time become available, time trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring the health of the workforce provides a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate the need for more detailed study or increased health and safety measures to ensure adequate protection for workers.

Memorandum of Understanding

The Department entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites, and the Centers for Disease Control and Prevention became responsible for conducting dose reconstructions in several host States, including Idaho. NIOSH is responsible for worker studies. These activities are funded by DOE. A number of studies of the Rocky Flats' workforce are ongoing under the Memorandum of Understanding.

A study is currently underway by NIOSH, under a cooperative agreement with the State of Colorado, to update the Rocky Flats cohort mortality and cancer incidence among Rocky Flats workers. This study should be completed in 1997.

The University of Colorado is conducting a sentinel exposure event surveillance/evaluation at DOE sites. This study will develop a sentinel exposure event surveillance and evaluation system for exposures to chemicals and both ionizing and non-ionizing radiation in the defense nuclear industry. The pilot will start at Rocky Flats in 1997.

The National Jewish Center for Immunology and Respiratory Medicine is conducting a study of lung fibrosis in Pu workers at Rocky Flats. The goal of the study is to confirm that Pu workers are at increased risk for

developing radiographic abnormalities consistent with fibrosis; to determine the relationship between Pu-239 and other radionuclide and chemical exposures and the development of lung fibrosis; and to determine the frequency of fibrosis on lung biopsies of Rocky Flats workers compared to biopsies from nonexposed individuals and to relate the clinical, physiologic, and pathologic severity to radionuclide dose.

Under a cooperative agreement with the State of Colorado, a study is being conducted of the relationship between the different types of leukemia commonly diagnosed in children and parental exposure to ionizing radiation used in medical procedures and received through occupational exposure.

M.4.9 LOS ALAMOS NATIONAL LABORATORY

Los Alamos and adjacent counties comprise a unique setting and history. The LANL for much of its existence was a closed community where most of the residents had direct economic ties to the Laboratory. Nearly all male residents and some of the female residents are employed at LANL. Medical care in Los Alamos County had been centralized at the Laboratory and a single community hospital. This is a unique, highly educated community situated adjacent to lands populated by Native Americans.

Surrounding Communities. Selected cancer mortality and incidence (newly diagnosed cancer) rates between 1950-1969, for eleven selected cancers among white males in Los Alamos County were compared with rates for the State of New Mexico, the United States five "socioeconomic and occupational" control counties, and five high education Western counties," based on U.S. Bureau of the Census information (ER 1981a:86-105). The comparisons were made to identify cancer types that were greater than expected while taking into account important factors, such as income and education, associated with cancer patterns. Six cancer types were identified that had rates greater than cancer rates for one or more of the four comparison groups; they are: cancer of the bile ducts and liver; bladder; prostate; brain and nervous system; lympho- and reticulo-sarcoma; and leukemia. Cancer rates of the prostate, bladder, and leukemia were also greater than expected.

Compared with New Mexico white males, Los Alamos County Anglo-white males show non-statistically significant excesses in cancer incidence from 1969-1974 for the stomach colon, rectum, pancreas, lung, and bladder (ER 1981a:86-105). All cancers combined show a 35 percent statistically significant excess. Los Alamos County white females show non-statistically significant excesses for cancer of the stomach, large intestine, lymphosarcoma and reticulosarcoma, and leukemia. All cancers combined show a statistically significant 40 percent excess.

In 1991, the New Mexico Department of Health initiated epidemiologic studies in response to citizen concerns about an apparent excess of brain tumors among residents of the western area neighborhood of Los Alamos County as a result of historical LANL nuclear operations. The New Mexico Department of Health conducted a descriptive study of brain cancer incidence in Los Alamos County and for 22 other sites (NM DOH 1993a). The study showed that during the mid- to late- 1980s an approximate 80 percent excess of brain cancer had occurred in Los Alamos County compared with a New Mexico reference population and national statistics. The excess incidence had disproportionately occurred among persons who were residents of the western area at the time of diagnosis or death; however, there were only three cases and they were confined to the 2-year time period, 1986 and 1987. Additional descriptive studies showed that the brain cancer rates for Los Alamos County were within the range of rates observed across New Mexico counties from 1983-1987 and 1988-1991. A review of mortality statistics for benign or unspecified neoplasms of the brain and nervous system showed no deaths from these causes in Western Area residents during 1984-1990.

Los Alamos County breast cancer incidence rates remained level but higher than New Mexico rates from 1970-1990. Reproductive and demographic factors associated with the risk of breast cancer were thought to account for the higher rates. A special study was conducted to examine the recent increase in breast cancer since 1988 (NM DOH 1994a). The New Mexico Tumor Registry concluded that the increase seen in 1988-1992 was primarily due to increased detection of early stage disease.

The incidence of ovarian cancer in Los Alamos County women was elevated from the mid- 1970s to 1990. From 1986 through 1990, ovarian cancer incidence in Los Alamos County was roughly two-fold higher compared with New Mexico reference population rates. The excess ovarian cancer rate was confined to a census tract corresponding to two neighborhoods and was four to six-fold higher than that observed in the remaining Los Alamos County census tracts.

The incidence rates for melanoma (cancer of the skin) in Los Alamos County workers elevated from 1970 through 1990, with peak elevations occurring from the mid- to late-1980's. There was approximately a two-fold excess risk compared with a New Mexico State reference population. The excess melanoma incidence observed in Los Alamos County was thought to be related to the high ambient solar ultraviolet radiation intensity due to its high altitude.

A four-fold increase in thyroid cancer incidence during the late 1980s was noted in a study by Athas (NM DOH 1996a). A case-series records review was initiated to examine data relating to the detection, diagnosis, and known risk factors for thyroid cancer. All cases of thyroid cancer diagnosed among Los Alamos County residents between 1970 and 1995 were identified through the New Mexico Tumor Registry. The incidence rate for thyroid cancer in Los Alamos County was slightly higher than New Mexico rates between 1970 and the mid-1980's. There was a statistically-significant four-fold increase during the late-1980s and early 1990s compared with the State, but the rate began to decline in 1994 and 1995.

The higher than expected number of thyroid cancer cases could not be explained by changes in diagnosis of thyroid cancer among Los Alamos County residents. Additional analyses suggested that increased medical surveillance and greater access-to medical care were responsible for the recent excess in Los Alamos County. Potential risk factors for thyroid cancer including therapeutic irradiation, genetic susceptibility, occupational radiation exposure, and weight were also examined. However, the investigation did not identify a specific cause for the elevated rate of thyroid cancer in Los Alamos County.

Male Workers. A mortality study of 224 white males with the highest internal depositions of Pu 239 (10 nanocuries or more) at LANL were examined by Voelz, et al. (LANL 1985a). Followup was through April 1980; SMRs were low for all cause of death (SNM=0.56, 95 percent CI=0.40-0.75), all malignant neoplasms (SMR=0.54, 95 percent CI=0.23-1.06), compared with U.S. white males and lung cancer (SMR=20, 95 percent CI=0-110).

A cohort mortality study by Wiggs et al. examined the causes of death among 15,727 white males hired at LANL between 1943 and 1977 (HP 1994a:577-588). The purpose of the study was to determine if Pu deposition and external ionizing radiation were related to worker mortality. After nearly 30 years of followup, the LANL workforce experienced 37 percent fewer deaths from all causes, and 36 percent fewer deaths due to cancer than expected when compared with death rates for the U.S. population.

The researchers identified a subset of 3,775 workers who had been monitored for Pu exposure; of these, 303 workers were categorized as "exposed" based on a urine bioassay for Pu; the remainder were "non-exposed." One case of rare bone cancer, osteogenic sarcoma, a type of cancer related to Pu exposure in animal studies, was noted among the Pu exposed group. The overall mortality and site-specific rates of cancer did not differ significantly between the two groups of workers. A non-statistically significant increase in lung cancer among the exposed group was noted, but there was no information on cigarette use among the workers.

When researchers examined data for the 10,182 workers who were monitored for exposure to external ionizing radiation (including 245 workers exposed to Pu) they observed a dose-response relationship for cancers of the brain/central nervous system, cancer of the esophagus, and Hodgkin's disease. When the 225 Pu-exposed workers were excluded from the analysis, there was a statistically significant dose response between external ionizing radiation and kidney cancer and lymphocytic leukemia.

A special lifetime medical study was conducted on 26 of the workers who have the largest internal depositions of Pu at LANL. Voelz and Lawrence reported on the 42-year follow-up of the 26 white males who designed and built the first atomic bomb and were determined to have had a significant deposition of Pu-239 sometime in 1944 or 1945 based on job assignment, working conditions, and urine levels of Pu (HP 1991a:181-190). Their mortality experience was compared to U.S. white males adjusted for age and calendar time. The mortality rates were also compared with rates for a cohort of Los Alamos workers hired at the same time and born between the same years; no significant differences were observed for all cause mortality and all cancer mortality. One of the seven reported deaths was due to bone sarcoma, the most frequent radiation-induced cancer observed in persons with radium depositions.

Wiggs reported on 6,970 women employed at LANL at least 6 months from 1943 through 1979, with deaths determined through 1981 (LA Wiggs 1987a). The mortality rates for all causes of death combined and all cancers combined were 24 percent and 22 percent below the rate for the U.S. population. Although the overall rates are low, women occupationally exposed to ionizing radiation have elevated rates for cancer of the ovary and of the pancreas relative to those not exposed. An unusual finding was that female radiation workers experienced a statistically significant excess of death from suicide. In a special in-depth study, the suicides were compared to two control groups, deaths from other injuries and deaths from non-injuries. History of employment as a radiation worker was significantly associated with death from suicide for both comparison groups. No significant associations for duration of employment, Pu exposure, or marital status were seen (APHA 1988a).

As a result of a reported three-fold excess of malignant melanoma among laboratory workers at LLNL in California and similarities between occupational exposures and prevailing sunshine conditions at LANL and LLNL, an investigation was undertaken to assess the risk of melanoma at LANL (Lancet 1981a:712-716). Incidence data were obtained from the New Mexico Tumor Registry. No excess risk for melanoma was detected at LANL among 11,308 laboratory workers between 1969 and 1978. Six cases were identified where about 5.7 were expected (Lancet 1982a:883-884). The rate for the total cohort, Hispanic males and females, non-Hispanic males and females were not significantly different from the corresponding New Mexico rates.

A special in-depth, study of fifteen cases diagnosed through 1982 did not detect an association between melanoma and exposure to any type of external radiation as measured by film badges, neutron exposures, Pu body burden based on urine samples, or employment as a chemist or physicist (HP 1983c:587-592). However, the melanoma cases were more educated than the comparison group using the college and graduate degree as a measure of education; a finding consistent with other reports of malignant melanoma according to the authors. The numbers in this study are too small to detect any but large excesses.

Memorandum of Understanding. The Department entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. NIOSH is responsible for managing or conducting the worker studies. The following multi-site studies that include LANL are currently underway: a study of mortality among female nuclear weapons workers; a case-control study of multiple myeloma; a leukemia study; and an exposure assessment of hazardous waste/cleanup workers.